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FOREST INSECT CONTROL IN CALIFORNIA

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BIOLOGICAL EVALUATION

ENVIRONMENTAL IMPACT EVALUATION

COST-BENEFIT EVALUATION

SAN BERNARDINO, SAN JACINTO AND WRIGHTWOOD

ZONES OF INFESTATION

SAN BERNARDINO NATIONAL FOREST

APRIL 1974

CALIFORNIA REGION
DIVISION OF TIMBER MANAGEMENT
BRANCH OF PEST CONTROL

OREST SERVICE

S. Department of Agriculture



630 SANSOME STREET
SAN FRANCISCO, 94111

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BIOLOGICAL EVALUATION
OF
BARK BEETLE INFESTATIONS

SAN BERNARDINO, SAN JACINTO AND WRIGHTWOOD
ZONES OF INFESTATION 1/

By
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INTRODUCTION

There are three Zones of Infestation on the San Bernardino National Forest: the San Bernardino, San Jacinto and Wrightwood. A Zone of Infestation is established by the California State Board of Forestry when an insect outbreak threatens private land. This enables the State to spend funds up to 50 percent of the total cost of the insect control project. Under the current cooperative agreement the State of California finances 50 percent, County Flood Control Districts 25 percent, and the Forest Service 25 percent of the total project costs. However, depending on available financing, tentative plans for Fiscal Year 1975 provide for 50 percent Forest Service cost sharing and 25 percent for the State of California and County Flood Control Districts.

A bark beetle control program has been underway in southern California since the early 1950's. Long-range insect control plans have been prepared for each National Forest Ranger District in accordance with guidelines currently located in R-5 Emergency Directive No. 1, FSM 5242.22f. These plans delineate project areas and indicate the intensity and type of treatment necessary. Coordination is set up with the California Division of Forestry for insect control on private lands. The program is approved by the California Forest Pest Control Action Council. The objective is to give the highest degree of protection feasible to recreation and timberland.

There are approximately 163,000 timbered acres of National Forest land and 62,000 timbered acres of private and State land within the San Bernardino National Forest boundary. Currently, about 107,000 acres are

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included in control projects either as Class I (continuous) or Class II (seasonal).^{1/} Of this, approximately 60,000 acres are National Forest lands and 47,000 acres are in private or State ownership. The acreage in the control program includes all major recreation areas and urbanized forest land within the Forest boundary.

Because of the importance of cooperative insect control projects on private land within the San Bernardino National Forest, this biological evaluation supplements the Insect Control Plans covering the Zones of Infestation. Special emphasis will be placed on the Arrowhead-Crestline outbreak within the San Bernardino Zone, as this infestation is sustaining the heaviest timber loss. Control recommendations will apply to all three Zones of Infestation.

SAN BERNARDINO ZONE OF INFESTATION

The first reported insect control project against the western pine beetle took place in 1921-22 in the Arrowhead-Crestline area. Sporadic outbreaks continued and in 1933-34 a so-called eradication project was undertaken on Federal and private land through the CCC program.

In 1939 a severe outbreak caused private landowners and the Forest Service to initiate a control program. The local San Bernardino County Flood Control District financed the work on private land and the Forest Service did the work on both private and Federal land. When the San Bernardino Zone of Infestation was established in 1946, it enabled the State to enter into a cooperative insect control agreement.

Periodic control efforts continued until 1949. In 1950, Entomologist Paul Keen, Pacific Southwest Forest and Range Experiment Station, recommended that a permanent control project be initiated. In the early 1950's an unprecedented bark beetle epidemic took place. The Forest Service continued to do the control work on both private and National Forest land until 1962 when the California Division of Forestry began to do some of the work on private land. Since 1965 the California Division of Forestry has had the responsibility of treating all private land.

^{1/} Control classes are divided into four intensities. An additional 103,000 acres of National Forest timberland and 15,000 acres of private land are designated as Class III and Class IV. Control is seldom warranted in these two classes, and is only justified by individual biological evaluations.

The following table summarizes the number of infested trees treated during the past 12-1/2 years in the Arrowhead-Crestline Area of the San Bernardino Zone.

Number of Trees Treated by Fiscal Year
(Arrowhead-Crestline Area)

Fiscal Year	National Forest Land	Private Land	Total
1962	305	2,247	2,552
1963	320	2,112	2,432
1964	830	1,831	2,661
1965	420	1,330	1,750
1966	352	643	995
1967	199	487	686
1968	155	567	722
1969	368	554	922
1970	927	2,839	3,766
1971	822	2,402	3,224
1972	728	2,637	3,365
1973	486	2,416	2,902
1974 (to 1-31-74)	362	1,847	2,209
GRAND TOTAL	6,274	21,912	28,186

CAUSAL AGENTS

The primary insects are the western pine beetle, Dendroctonus brevicomis, in ponderosa and Coulter pine and the Jeffrey pine beetle, Dendroctonus jeffreyi, in Jeffrey pine. Some tree killing is caused by the California flatheaded borer, Melanophila californica; the mountain pine beetle, Dendroctonus ponderosae; and the pine engraver beetles, Ips spp. The red turpentine beetle, Dendroctonus valens also attacks environmentally stressed pine.

HOST TREES

The four main tree species are ponderosa, Pinus ponderosa, Jeffrey pine Pinus jeffreyi, Coulter pine, Pinus coulteri, and sugar pine, Pinus lambertiana. These species are associated with white fir, Abies concolor, incense-cedar, Libocedrus decurrens, and black oak, Quercus kelloggii.

LOCATION AND EXTENT OF INFESTATION

The San Bernardino Zone of Infestation covers about 108,000 gross acres. The Zone is further divided into three general areas: Arrowhead-Crestline, Big Bear and Barton Flats, which corresponds to the Ranger District organization.

TYPE OF DAMAGE

Chronic bark beetle-caused tree mortality has been and continues to be a major problem in the San Bernardino Zone of Infestation. Some of the adverse impacts of tree mortality on recreation forests are: (1) reduced esthetic values, (2) increased hazard to persons and property, (3) increased fire hazard, and (4) monetary loss through: (a) fewer visits, (b) reduced property values, (c) insect control treatments, and (d) dead tree removal.

ENVIRONMENTAL AND OTHER FACTORS

Current knowledge indicates that adverse environmental factors that injure trees or cause stress, reduce the tree's resistance to bark beetle attack. Some of the factors significantly influencing the current bark beetle population are air pollution, urbanization, recreation, moisture, fire, and sanitation logging.

Air Pollution. In the early 1950's a decline of ponderosa pine was observed in the San Bernardino Mountains but the causal agent was unknown. It was referred to as chlorotic decline, X-disease, and other local names. Air pollution (smog) became suspect and finally in 1965 the problem was specifically identified as air pollution damage caused by photochemical oxidants. Field symptoms were duplicated by fumigating ponderosa pine with ozone, the major component in photochemical oxidants.

A correlation exists between trees damaged by air pollution and trees infested with bark beetles in the San Bernardino National Forest. In 1969, 80 percent of the bark beetle-infested trees were also smog damaged. However, field observations indicate that smog damaged ponderosa pine successfully attacked by mountain or western pine beetle contain shorter egg galleries and produce fewer broods. Smog affected trees have reduced carbohydrates, phloem moisture and phloem thickness, which may diminish the nutritional value of the food source available for bark beetle broods.^{1/}

Urbanization. One of the major stresses on a forest is the phenomenon known as urbanization. This is certainly true within the San Bernardino Zone of Infestation. When construction in the forest stand begins, both the site and trees are often adversely affected. Tree boles are damaged and roots are severed or suffocated by fill material. Trees are removed and the resulting slash is allowed to accumulate. This often precipitates a buildup of pine engraver beetles which can move into living trees.

San Bernardino County, in an effort to curb unnecessary bark beetle problems, enacted a County Ordinance in 1967 which requires the landowner to dispose of any green slash on his property within 15 days after cutting. Although the effects of development continue, this is a positive step to help stem the adverse effects of urbanization in the forest stand.

^{1/} A complete discussion on "Photochemical Oxidant Injury and Bark Beetle Infestation of Ponderosa Pine" may be found in the May 1968 issue of *Hilgardia*, a publication by the California Agriculture Experiment Station.

Recreation. The San Bernardino and San Jacinto Mountains received 12 million visitor-use days in 1973. Such intense recreational use creates a number of impacts which predispose trees to insect and/or disease attack. Examples of those impacts would be soil compaction from vehicle and foot traffic, mechanical damage to roots and stems, and lowering of the water table.

Moisture. It has been generally accepted that periodic drought conditions have been responsible for many western pine beetle epidemics. This has been particularly true in southern California. Drought periods have been cyclic and prior to 1965, sixteen of the previous 20 years had below-normal precipitation. Annual precipitation alternated from wet to dry years from 1965 to 1970. From 1970 through 1972, annual moisture has fallen below the 10-year average of 41.22 inches as recorded at Lake Arrowhead. Those annual averages for 1970, 1971, and 1972 were reported as 34.70, 36.15, and 16.03 inches, respectively. Precipitation for 1973 was 47.61 inches, which is slightly above normal. However, with below-normal moisture expected for 1974, there will be continued stress on the timber stands.

Fire Damage. The Bear Fire burned over 53,000 acres in November 1970 which contained 9,300 acres of timber. Approximately 4,500 acres were logged by conventional methods. Another 3,500 acres were logged by helicopter by the end of Fiscal Year 1973. Volume removed by helicopter reached 4 MMBF. Fifty percent of the volume came from green, high-risk trees and 50 percent from fire-damaged trees. All material was 20 inches d.b.h. or larger.

Burned timber on about 1,600 acres of private land was treated or logged by private contractors with funds provided under Public Law through the Office of Emergency Preparedness (OEP). The administration of the project was handled by the Corps of Engineers with the project completed on December 1, 1971. Bark beetles were a problem in green timber outside the burn in 1973.

Selective (Sanitation) Cutting. Sanitation treatment (selective cutting) was initiated on the San Bernardino National Forest in 1953 at Barton Flats. Entomologist Ralph Hall estimated that during the first two-year period after treatment losses dropped to less than 10 percent of those prevailing prior to treatment. It is expected that a selective cut will be effective from 8 to 12 years.

<u>Sale</u>	<u>Estimated Volume (MMBF)</u>	<u>Acres</u>
Snow Valley	1.0	500
Bluff	3.8	6,590
Camp Angeles	1.0	560
	5.8	7,650

BIOLOGICAL INFORMATION

Bark beetles are primarily in the larval stage and are occasionally in the pupal stage on the south side of the trees. The California flat-headed borer is primarily in the pre-pupal stage.

Arrowhead-Crestline. Western pine beetle, mountain pine beetle, red turpentine beetle and pine engraver beetles are attacking green ponderosa and Coulter pine in the vicinity of Smiley Park (Bear Fire). The western pine beetle and mountain pine beetle infestation is continuing, particularly in the pine weakened by photochemical air pollution. The best estimate is that this mortality will continue to be high in 1974.

Big Bear. Jeffrey pine, red turpentine and pine engraver beetles are continuing to attack fire-damaged Jeffrey pine in the Bear Burn. At Big Bear Lake the Jeffrey pine beetle is in a high endemic status and moderate losses will continue.

Barton Flats. Western pine beetle, red turpentine beetle, and ips are attacking Coulter and ponderosa pine at Thomas Hunting Ground (Bear Fire). Elsewhere, western pine beetle in ponderosa pine and Jeffrey pine beetle in Jeffrey pine are continuing to cause scattered mortality, primarily in oxidant-injured trees. The best estimate is that this mortality will remain at the 1973 level.

DISCUSSION

Nearly 3,000 trees were treated in the Arrowhead-Crestline infestation during Fiscal Year 1973. A number of trees were missed because of oxidant injury complications. All advanced oxidant-injured trees are chlorotic in appearance and often no change in fade is apparent after bark beetle attack. Many trees are attacked above 10 feet with little evidence of pitch tubes or boring dust. Therefore, spotting has become a very difficult job with more trees being missed than in previous years.

Field observations indicate that pine severely injured by oxidants have smaller bark beetle populations. If this is true, it would significantly change the reproductive potential of the bark beetles involved. In the 1972 biological evaluation it was recommended that a research project be initiated on bark beetle brood development and production in trees injured by photochemical air pollution. A research project on this problem is being financed by the Environmental Protection Agency. This is only a portion of a large research project, "The Impact of Oxidant Air Pollution on the Mixed-Conifer Ecosystem," which will be funded for a five-year period. However, data will not be available for several years.

In October of 1973 reports indicated that an epidemic was at hand in the Crestline-Arrowhead area. Field checks verified these reports. Large trees with little or no smog damage were being attacked and killed. Larval population counts were one per square inch or greater in some trees.

In order to halt this pending outbreak the three cooperating agencies provided additional funds. These funds enabled the California Division of Forestry to field two Ecology Corps crews to do insect control work. By January 31, 1974, the State had already treated over 1,800 trees. This is nearly double the number of trees treated the previous year.

SAN JACINTO ZONE OF INFESTATION

Winter projects to suppress the western pine beetle and mountain pine beetle were started in 1946. In 1953, the California flatheaded borer was first recognized as an important tree killer and was included in the seasonal insect control program. In 1955, a cooperative insect control program was initiated on private land. The Forest Service did the work on both private and National Forest land. In 1956, it was recommended that insect control be done on a year-around basis and that sanitation treatment be initiated wherever possible. Year-around control was attempted, but did not become operational until 1959. In 1964, The California Division of Forestry, under cooperative agreement, assumed the responsibility for all insect control on private land.

From 1956 to 1965 a severe western pine beetle epidemic killed thousands of trees within the Zone. One area, Baldy Mountain, was left untreated because of insufficient funding and about 70 percent of this almost pure Coulter pine stand was destroyed. Since 1956, the most severe tree killing has been caused by the California flatheaded borer in Jeffrey pine, located in Garner Valley.

Most of the commercial National Forest timber has had a sanitation cutting and some of the areas are scheduled for the second cutting. Some private land has also had a sanitation cutting.

Number of Trees Treated in Fiscal Year
(San Jacinto Zone)

Fiscal Year	National Forest Land	Private Land	Total
1969	157	1,120	1,277
1970	157	1,127	1,284
1971	158	832	990
1972	190	1,691	1,881
1973	365	1,123	1,488
1974 (to 1-31-74)	405	811	1,216
GRAND TOTAL	1,432	6,704	8,136

CAUSAL AGENT

The primary insects are the California flatheaded borer, Melanophila californica, in Jeffrey pine, and the western pine beetle, Dendroctonus brevicomis, in ponderosa and Coulter pine. Occasionally the mountain pine beetle, Dendroctonus ponderosae, causes some tree killing in sugar pine. The pine engraver beetles, Ips spp., and red turpentine beetle, Dendroctonus valens, will attack all the pine species, but under most conditions are considered secondary. It is interesting to note the aggressiveness of the California flatheaded borer in the absence of the jeffrey pine beetle.

HOST TREES

The four main tree species are ponderosa pine, Pinus ponderosa, Coulter pine, Pinus coulteri, Jeffrey pine, Pinus jeffreyi, and sugar pine, Pinus lambertiana. These species are associated with white fir, Abies concolor, incense-cedar, Libocedrus decurrens, and black oak, Quercus kelloggii.

LOCATION AND EXTENT OF INFESTATION

The San Jacinto Zone of Infestation was established in 1946 and increased in 1954 and again in 1959 for a total of 57,600 gross acres. The Zone is divided into three general areas - Idyllwild, Garner Valley, and Black Mountain, all within the San Jacinto Ranger District.

TYPE OF DAMAGE

Chronic bark beetle-caused tree mortality has been and continues to be a major problem in the San Bernardino Zone of Infestation. Some of the adverse impacts of tree mortality on this recreation forest are:

- (1) reduced esthetic values, (2) increased hazard to persons and property, (3) increased fire hazard, and (4) monetary loss through: (a) fewer visits, (b) reduced property values, (c) insect control treatments, and (4) dead tree removal.

ENVIRONMENTAL AND OTHER FACTORS

Precipitation in Calendar Years 1971 and 1972 was 19.82 and 13.20 inches, respectively, which both fell below the 24.79 inch annual average. In 1973, 31.29 inches of precipitation fell. Rainfall to March 5, 1974 reached only 13.05 inches. Oxidant air pollution has begun to weaken trees on the San Jacinto District. Urbanization, particularly around the community of Idyllwild is having a definite adverse effect on the forest stand. (See Environmental Factors - San Bernardino Zone of Infestation.)

San Jacinto District has an active salvage logging program to remove dead and dying trees injured by fire, insects or smog. In 1972, 600 MBF were logged from the May Valley Burn (including some high-risk timber). During Fiscal Year 1973, two sanitation sales were made:

the Garner (500 MBF), and Black Mountain (1 MMBF). The Vista Fire which occurred in August 1972 was logged by a combination of helicopter and tractors. Approximately 2.6 MMBF were salvaged.

DISCUSSION

The major insect problem in the San Jacinto Zone continues to be the California flatheaded borer. This beetle is not normally considered to be an important tree killer, but it has unique status in southern California as a primary tree killer in many areas. Unfortunately, the reasons for this are not understood. Therefore, it would be desirable to have a study on the population dynamics of the California flatheaded borer in southern California. When this information becomes available, better pest management decisions for controlling this insect can be made.

WRIGHTWOOD ZONE OF INFESTATION

In 1957, insect-caused tree mortality in Jeffrey pine began to increase at an alarming rate in and around the town of Wrightwood. An evaluation indicated that the major insect responsible was the California flatheaded borer. The Wrightwood Zone of Infestation was established in November 1958 and control operations began in the fall of 1959.

CAUSAL AGENTS

The primary insects are the California flatheaded borer, Melanophila californica and pine engraver beetles, Ips spp. The Jeffrey pine beetle has never been observed in the stand.

HOST TREES

The only species affected is Jeffrey pine, Pinus jeffreyi. The stand is dominately pole-sized Jeffrey pine with scattered mature timber.

LOCATION AND EXTENT OF INFESTATION

The Wrightwood Zone of Infestation covers about 7,000 acres and control work is done on about 2,000 acres which is within and around the community of Wrightwood. Most of the infestation is on private land. The Zone is entirely within the Cajon Ranger District.

ENVIRONMENTAL AND OTHER FACTORS

Drought has been a major stress factor to the timber stand in the Wrightwood Zone of Infestation. Prior to 1965, sixteen out of the last twenty years had below-normal precipitation. The years, 1965 through 1970, recorded normal or above precipitation. Below-normal moisture was recorded again in 1971 and 1972 when 22.06 and 9.75 inches fell, respectively. Total precipitation for 1973 was 27.77 inches. The annual precipitation average as recorded at the Big Pines Fire Station is 25.04 inches.

Urbanization is a major stress factor. Most of the losses are occurring in the community of Wrightwood, and the effects of construction and development are taking their toll. Fortunately, air pollution has not yet had visible effects on the stand. (See Environmental Factors - San Bernardino Zone.)

BIOLOGICAL INFORMATION

The California flatheaded borer is overwintering in the late larval and pre-pupal stages, while ips are found in all stages. A slight increase in tree mortality is predicted for 1974 due to the buildup of the insect population from past drought years. The average or better moisture recorded in Fiscal Year 1973 has not alleviated that particular stress factor.

DISCUSSION

So far, it has not been feasible to have a sanitation cutting or other silvicultural treatment in this urban situation. Consequently, direct control measures by tree removal (woodcutters) and by spraying with an insecticide have been the major treatments used.

DISCUSSION ALL THREE ZONES OF INFESTATION

Timber stands on the San Bernardino National Forest continue to decline in health and vigor in spite of one year of normal rainfall. Consequently, in many areas, individual trees can no longer successfully compete with their neighbors. In order to increase the health and vigor of the stand, it is necessary to reduce the stand stocking to a level which will allow the residual stand to compete successfully for available moisture. The best way to attain stocking reduction of merchantable timber is to harvest the high-risk trees by a selection cut. Some additional follow-up silvicultural treatment (thinning, dwarf mistletoe control) may be necessary in overstocked stands of unmerchantable trees.

The magnitude of the current infestation indicates that it is necessary to use all suppression methods available in order to effectively suppress the infestation. Salvage logging and fuelwood sales offer the best alternative for suppression of infested timber through removal of the infested material from the forest environment.

In order to aid the salvage logging of insect-infested trees, it is suggested that SALE BY VOLUME be considered, rather than sale by area. This allows for greater flexibility in removal of the infested trees before the bark beetles have emerged. Also, if the estimated volume of infested trees is less than 90 percent of the total estimate, additional green, high-risk timber can be marked in order to reach the original estimated volume. (See Sale Contract Provisions C2.365, C2.41 and C6.311 for details.)

Fuelwood sales can provide an outlet for unmerchantable infested material when that material is moved several miles from the Forest. Therefore, professional woodcutters and residents with wood storage areas away from the coniferous type can be utilized.

The chemical treatment of infested trees in high-use areas not conducive to logging or wood sales should continue. Federal and State crews should coordinate their activities on contiguous, high-use areas.

Historically, bark beetle outbreaks have often developed the third year following a damaging fire. Some of the fire-damaged timber is in extremely steep terrain which cannot be logged by conventional methods. Logging these areas by helicopter continues to be an excellent tool and the San Bernardino National Forest is leading the way. In the past, cutting and burning these trees has been an effective method to prevent bark beetle buildup. Now, local air pollution control agencies have restrictions which usually prevent burning.

Tree damage results at construction or development sites in forested areas undergoing rapid urbanization. Bark beetles are attracted to these injured or stressed trees. Therefore, an intensive program to educate the public on measures which prevent construction-related bark beetle problems is required. Construction practices are often detrimental to tree growth and vigor. Some adverse practices which should be avoided are: (1) the cutting of roots, (2) the accumulation of slash, (3) the covering of pine roots and root collars with dirt or asphalt, (4) major disturbances of the drainage, (5) direct injury to the bole of trees, and (6) structures constructed too close to live trees.

RECOMMENDATIONS
ALL THREE ZONES OF INFESTATION

The practice of evaluating bark beetle infestations has not yet developed into an exact science. Although improved tools and methods are under development for evaluation, these are not yet available, and as in the past, the need for suppression is judged primarily on the basis of tree mortality and the environmental factors affecting the area. Experience has shown that when suppression efforts are curtailed or terminated and a period of drought or other adverse conditions continues, an increase in bark beetle-caused tree mortality occurs.

Three recommendations are made which should help to suppress the chronic bark beetle problem on the San Bernardino National Forest.

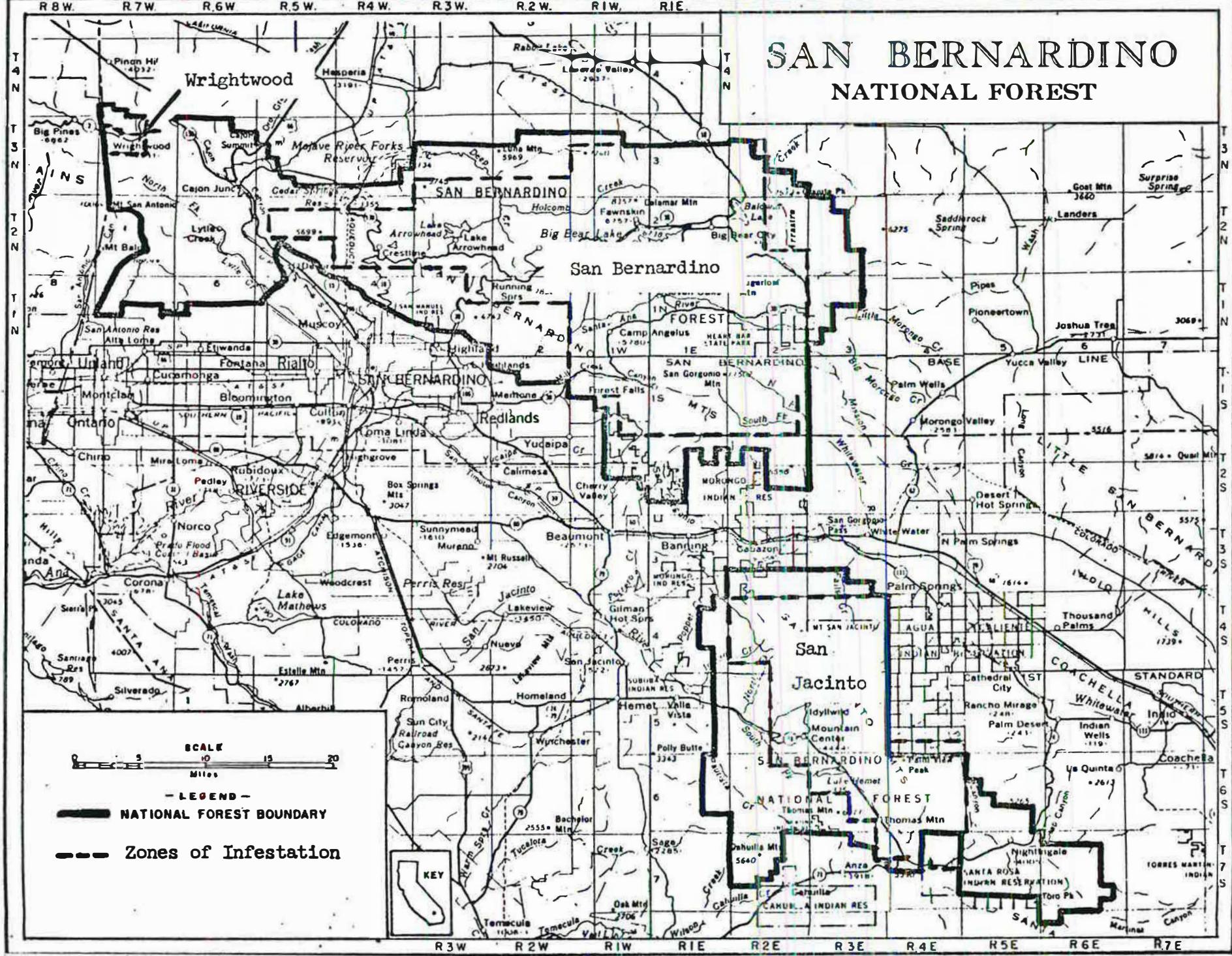
1. Continue the control program on both National Forest and private land.

Considering the high recreation and property values at stake; recognizing that increasingly unfavorable environmental factors of drought, air pollution damage and fire damage will probably cause increased bark beetle damage; this is the best method available to attain minimal loss levels in recreation and urbanized forests. Control includes the following practices which should be given consideration in the following order of priority:

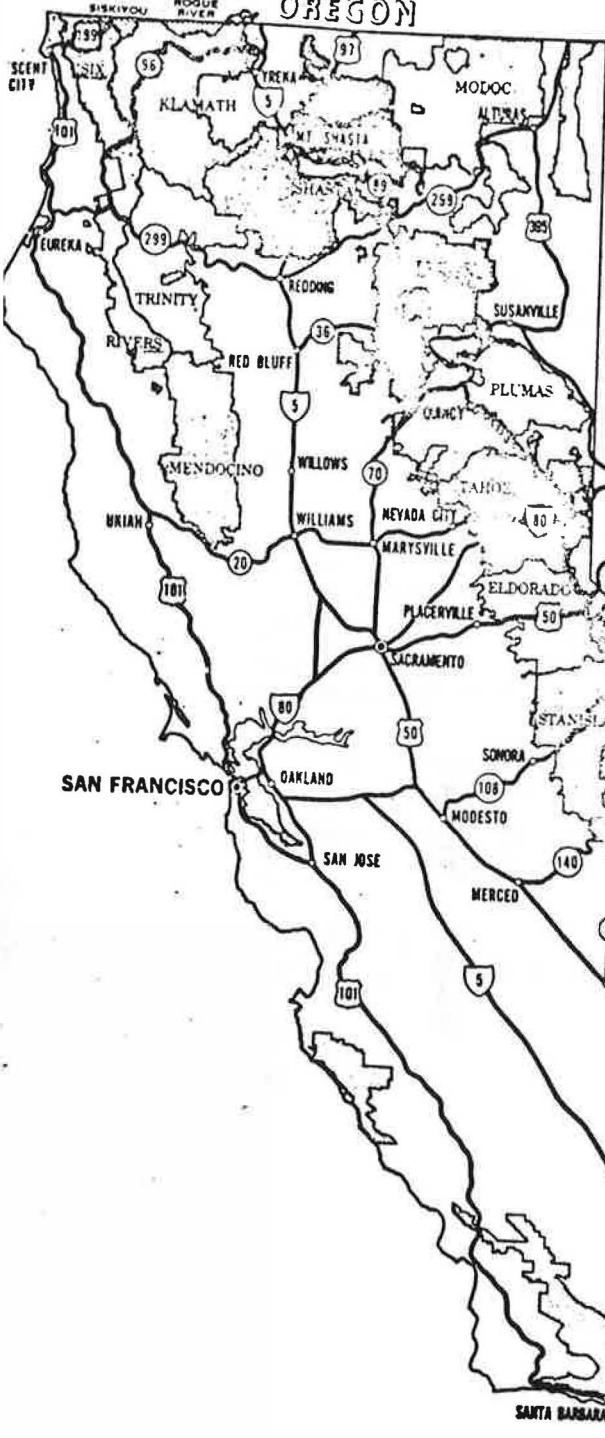
- (1) Sanitation cutting should be continued on National Forest land and initiated on private land where it **is feasible**.
- (2) Silvicultural treatment such as commercial or pre-commercial thinnings and release in overstocked stands should be continued and/or initiated on all ownerships.
- (3) When possible, removal of insect-infested trees should be accomplished by salvage logging or wood-cutters. Be sure infested material is removed from the forested environment.
- (4) When necessary, infested trees can be treated with a 1.5% lindane spray. Application instructions are found in R-5, FSM 5240, Emergency Directive No. 1, dated May 3, 1968. Lindane applied in accordance with instructions will have minimal adverse effects on human health, wildlife, fish or domestic animals.

2. Initiate a more intensive program for educating the public on good preventive measures to avoid bark beetle damage to forest trees.
3. A study should be initiated on the population dynamics of the California flatheaded borer in southern California. (R.O. responsibility)

SAN BERNARDINO NATIONAL FOREST



OREGON



SAN BERNARDINO NATIONAL FOREST
BARK BEETLE CONTROL PROJECTS

ZONES OF INFESTATION

WRIGHTWOOD

SAN BERNARDINO

SAN JACINTO

NEVADA

SAN BERNARDINO

SAN BERNARDINO

MEXICO

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.



USE PESTICIDES SAFELY

ENVIRONMENTAL IMPACT EVALUATION
SAN BERNARDINO, SAN JACINTO AND WRIGHTWOOD
ZONES OF INFESTATION

INTRODUCTION

Timber stands in the San Bernardino National Forest harbor chronic populations of California flatheaded borer and bark beetles in the *Dendroctonus* and *Ips* genera. Insects continue to be a problem because of the stress factors placed on southern California forests. Some stresses are: (1) smog and other forms of pollution, (2) intense recreation use, (3) urbanization, (4) lowering water table, (5) fires, and (6) drought condition from 1969 through 1972.

Harmful forest insects like forest fires must be dealt with on a continual basis as they occur. Therefore, a control project was developed to suppress insect pests to a tolerable level. The project provides an integrated approach to insect control. One part of control is direct control, i.e., the infested trees will be logged, removed by woodcutters or felled and sprayed with an insecticide.

In large infestations the best method to suppress the beetle populations is by removal of infested material through logging and fuelwood cuts. Large volumes of infested material are removed, treatment expenses are kept low, and need for chemical control is minimized.

Infested trees adjacent to structures and in or near campgrounds or other special or high-use sites do not lend themselves well to removal through logging or fuelwood cuts. Yet these infested trees, though only a small percentage of the total, are precisely those with the highest priority for control because of their proximity to other high-value uninfested pine. Chemical treatment with an insecticide is best suited for these problem areas. The insecticide lindane is registered and recommended by the Forest Service for California flatheaded borer and bark beetle control in California. Individual infested trees are felled, bucked and limbed and the bark sprayed with a 1.5 percent solution of lindane and diesel oil.

I. ENVIRONMENTAL IMPACT

Lindane spray will be applied in low dosages to individual felled trees. Lindane-diesel oil forms a tissue deposit (no lindane on bark surface), so environmental contamination will be kept to a minimum. One of the major concerns of organochlorine compounds, such as lindane, is that it may be transferred in the food chain through a phenomena called biological magnification. Dr. Francis Gunther (personal communication, Branch of Pest Control, Region 5), Chemist and Toxicologist, at the University of California (Riverside) stated that he knew of no instances where lindane went through biological magnification. Dr. Gunther is the editor of the 1970 edition

of Residue Reviews and a renowned authority on insecticides. Macek (1970) said that lindane and methoxychlor would not be expected to be biologically magnified to any great degree.

A. Air

Lindane is stable to air, light, heat, and carbon dioxide. (Martin, 1968) No air pollution should occur through treating felled trees with a lindane-oil solution.

B. Natural Beauty

Much of the area is visible from roads, trails, and lakes. Because of the small number of trees to be felled the visual impact will be negligible. Slash created by insect control work will be handled in a manner that is consistent with the objectives of the Ranger District Multiple Use Plans and the Sub-Regional Guidelines. The removal of sorrel, and red-top trees from near and distant view areas will enhance the natural beauty, not detract.

C. Range and Plant Life

Lindane is considered to be nonphytotoxic at insecticidal dose levels.

D. Soils

With proper application procedures, very little of the lindane-oil solution should reach the soil. Lindane is moderately stable in soil and is fairly resistant to removal from the site of application by physical factors. (Lichenstein, 1959) Also, lindane degrades in soil to pentachlorocyclohexene (PCCH) which is more volatile than lindane, and does not remain in the soil to any extent. (Guenze, 1970)

E. Water

There are several small lakes in the project areas but only a few intermittent streams. However, no infested trees will be felled in these stream courses. Lindane has very little movement in the soil, hence, there should be no effect on water quality or stream flow.

F. Fish and Wildlife

With the low dosage and direct application only to the bark of felled trees, no effect on fish and wildlife is expected. Keeping away from streams or lakes is mandatory.

Fish. Generally, most insecticides are toxic to fish. The chlorinated hydrocarbons are particularly toxic. However, lindane is considered to be one of the safer chlorinated hydrocarbons. (O'Brien, 1967)

Brown and rainbow trout were all killed by exposure to 0.05 ppm of lindane, but bluegills have survived 0.45 ppm of 12 percent lindane.

However, bass and bluegill fingerlings suffered 50 percent mortality at 0.1 ppm of the same formulation. (Rudd, 1956) Four species of fish were exposed to water containing 0.03 ppm lindane. Two days after termination of exposure, the fish had eliminated 90 percent of the lindane. (Gakstatter and Weiss, 1967)

Birds. Numerous tests have been made feeding various birds on a diet of certain percentages of lindane. A 10 percent mortality of pheasants resulted from eating grain treated with one and two-thirds ounces of 75 percent lindane per 100 pounds over a 20-day period. However, other investigators were unable to detect noteworthy changes in the bird population of a 40-hectare pasture and woodland treated with 10 percent BHC (10 percent gamma) at approximately 50-70 pounds per acre. This application is about twice that normally employed. In addition, considerable field observation and experimentation in Germany have led essentially to the same conclusion. The small amounts of BHC that a wild bird could ingest would be insufficient to cause harm, due to the rapid disintegration of the material (BHC) within the animal body. (Rudd, 1956)

In summary, the National Academy of Sciences (1969), indicates that field applications of lindane have no toxic effect on birds.

Animals. The chronic toxicity of BHC, with the exception of the beta isomer (this isomer not in lindane) is relatively low. Technical BHC and lindane have been rated as one half and one quarter, respectively, the toxicity of DDT. Minimal storage, rapid elimination from the body and lesser degree of tissue damage are the criteria for this rating. (Lehman, 1950)

According to the National Academy of Sciences (1969) mammals metabolize lindane quite rapidly to trichlorobenzenes and phenols, which are excreted, and thus accumulate very little in the body fat. Hence, in mammals it has a low oral toxicity. (O'Brien, 1967)

G. Man

The U. S. Department of Health, Education and Welfare reports that there have been no confirmed cases of systemic poisoning in man as a result of repeated exposure to BHC (comparable to lindane). A Roumanian study showed no ill effects from massive inhalation of DDT plus lindane in a forest spraying operation; some workers inhaled 21 mg/kg of DDT as well as 6 mg/kg of lindane daily for 30 days. (O'Brien, 1967) Lindane is absorbed through the skin and other portals. Lindane has the highest mammalian toxicity but is also rapidly excreted by the kidneys and hence does not accumulate extensively. It therefore has the lowest toxicity on repeated dosages. (Hayes, 1963)

H. Wilderness Areas

There are no wilderness areas in the project.

II. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

A temporary reduction of certain beneficial and associated insects as well as some soil arthropods is probable. Two common predators of the western pine beetle, Enoclerus lecontei and Temnochila chlorodia, are quite easily killed by lindane. (Swain, 1968)

III. ALTERNATIVES TO THE PROPOSED ACTION

A. Log Infested Trees

This method is very desirable in low-use areas but difficult in recreation and heavily urbanized areas. Nevertheless, an all-out effort will be made to log infested trees in fiscal 1975.

B. Removal of Infested Trees by Woodcutter

Usually only a small number of trees can be handled in this manner as it is difficult to remove the trees before insect emergence. Another problem is that the infested material must be removed from the forest environment if the treatment is to be effective. Hence, this precludes the use of local woodcutters.

C. Fell, Peel and Burn Infested Trees

The fire hazard in southern California generally will not permit this type of treatment. Also, the effects of charred debris and scorched vegetation is undesirable in most of the areas. Local Air Pollution Control Board ordinances prohibit burning in some areas.

D. Use Ethylene Dibromide Instead of Lindane

Ethylene dibromide is a fumigating insecticide and has limited effectiveness, particularly in cold weather. Because of its short residual life it will not protect the uninfested portions of treated trees from attack by forest insects. Ethylene dibromide poses a greater hazard to treatment crews than does lindane as it is notorious for causing skin irritations resulting from direct contact. Breathing its fumes causes lung irritation.

E. Discontinue Insect Control Work in the Area

This should be regarded only as a theoretical alternative as it would have an intolerably adverse effect on the land value and the forest resource that people value for temperature modification, recreation, esthetics, shade and timber production.

IV. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

There are no irreversible commitments except the finality of cutting a tree which would soon become a snag. Some snags always remain for wildlife habitation. Also, tree regeneration may take place in areas where trees have been cut.

V. CONSULTATION WITH OTHERS

There is consultation on a special and continuing basis with State agencies, institutions of high learning, and other Federal agencies as well as Forest Service personnel. Some of the agencies involved are the California Department of Food and Agriculture, California Division of Forestry, California Department of Fish and Game, Fish and Wildlife Service, and Pacific Southwest Forest and Range Experiment Station. Institutions consulted include San Diego State University and the University of California at Berkeley and Riverside.

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COST-BENEFIT EVALUATION

SAN BERNARDINO, SAN JACINTO AND WRIGHTWOOD ZONES OF INFESTATION

INTRODUCTION

The bark beetle control program on the San Bernardino National Forest was initiated to suppress bark beetle populations so insect-caused tree mortality could be held to a minimum. Likewise, timber harvest cuts were primarily initiated to improve the health and vigor of the stand for recreation and watershed purposes. Lumber production is considered to be a secondary use.

Resource Values. The San Bernardino National Forest offers an easily accessible forest environment to more than 10 million people in the Los Angeles Basin. Seven lakes are available for recreational use, 73 campgrounds and 14 picnic sites. Forty organizational camps average 15,000 children per day in the summer. The Forest recorded 12 million visitor use days in 1973, which ranks as the heaviest recreation use of any National Forest in California.

Much of private forest land has become urbanized. Areas such as Lake Arrowhead have many homes in the \$100,000 class. Also, many residences are now being used on a year-around basis rather than just for recreation use. Land sold with pine trees often sells for \$2,000 per acre higher than land without pine trees.

In addition, the Forest has 163,000 acres of commercial timber land which is harvested by the sanitation cutting method.

It is necessary to give this valuable recreation and timber land the highest degree of protection possible. Continued tree loss would have an intolerably adverse effect on the land value and the forest resource that people value for recreation, esthetics, shade, and timber production.

Suppression Costs. An integrated control program will be used in Fiscal Year 1975 to treat the anticipated several thousand trees that will be infested. Hopefully, the bulk of infested material will be removed by salvage logging with a portion of the residual and some small-diameter trees sold as fuelwood. These sales should return the same amount of capital as was expended, and will save several thousand dollars which would have been needed for chemical control.

Chemical control will be required in developed areas. The Forest Service treats infested trees on National Forest land. They participate in cooperative insect control projects with the California Division of Forestry and San Bernardino and Riverside County Flood Control Districts which provide financing for the California Division of Forestry to treat infested trees on private lands.

Estimated suppression costs for Fiscal Year 1975 are given below:

- A. Forest-wide (N.F.): 1,900 trees at \$37.50/tree..... \$71,267
- B. San Bernardino Zone (Pvt.): 4,000 trees at \$17.38/tree ... \$69,531
- C. San Jacinto Zone (Pvt.): 1,500 trees at \$13.33/tree \$20,000
- D. Wrightwood Zone (Pvt.): 120 trees at \$20.16/tree \$ 2,420